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Objective: To establish physiological base line data and to develop instrumentation necessary for the automatic measurement of hemodynamic and metabolic parameters on primates during prolonged periods of weightlessness.

Status: At the termination of the period covered by this report the primate colony consisted of 34 animals. In general, the health of the colony has been satisfactory. During quarantine, several of the more recent arrivals have experienced an extended period (2 to 3 weeks) of diarrhea of an unclassified origin. No evidence of pathogens was revealed by autopsy of one of these animals. The balance of the animals in question has made considerable improvement. The incidence of this problem has been confined to individually caged animals in a separate room from the balance of the colony.

Microfilariae have been detected in the blood of one male pig-tailed monkey.

The thoracic surgical approach for implanting the vascular catheters has proved to possess definite advantages over the retroperitoneal approach. A modification of the thoracotomy procedure has involved the placement of

catheter tips within the left atrium and in the aorta. This should permit the use of either saline or dye solution to determine cardiac output by the single injection indicator-dilution method. The use of saline as an indicator would simplify some of the instrumentation requirements associated with long-term (30 days) storage of indocyanine green.

Reproduction and Growth

An outdoor breeding colony of three female and one male pig-tailed monkey has been maintained since 1963. One of the females gave birth to a single male offspring on 17 December 1963, as reported previously. The other two females each gave birth to single male offspring on 1 March and 3 March 1964, respectively. Continuous observational data were obtained prior to, during and immediately following parturition. The three females conceived within one month following exposure to the male. These monkeys have free access to either a fenced outdoor area (80 feet long by 20 feet wide by 15 feet high) or an inside area (10 feet by 10 feet by 15 feet) with one wall radiant heated to 70°F. Regardless of weather conditions, they seem to spend a considerable portion of the daylight hours in the outside area.

Anthropoidimetric measurements of the male born 17 December 1963 are shown in Table I. In order to make these measurements he was removed from his mother in the breeding colony area, anesthetized with a Nembutal(R) solution containing 150 U.S.P. units of Wydase(R) (lyophilized hyaluronidase). This anesthetic was administered intramuscularly. In addition to gross anatomical measurements, whole body X rays, finger and hand prints and electrocardiographic records were obtained. A preliminary pattern of odontiasis has been ascertained. At 90 days of age all eight of the deciduous incisors and the four canines had emerged. The first deciduous molar had just erupted at 90 days of age. At 168 days the second deciduous maxillary

molars had not quite erupted to the position where the entire top of the tooth crown pierced the gum.

The infant pig-tailed monkeys in the breeding colony stayed close to their mothers during the first month of life. During the second month they roamed an area within 3 feet from the mother and made an attempt to eat dry food pellets. From the third month, they were able to chew and consume some food pellets rather easily, although even at 6 months of age they frequently returned to grasp and suckle the mother. The presence of their offspring in the breeding area has not deterred these post-parturient females from accepting the male in coitus. Whether these reproductive cycles are fertile or not has not been determined.

Hematology.

Tables 2 and 3 contain hematological data from 2 mature pig-tailed monkeys confined for 90 day periods in the couch configuration described in Status Report No. 2. The data reported in Table 2 were obtained from a monkey (#2, Bottom) without implanted catheters. The total weight of the couch and monkey was made twice a week. A tare weight of the couch and confining jacket was determined just before the start of the trial. Blood samples were obtained by puncture of the lesser saphenous vein. Food and water consumption and urine and feces production were measured daily. When removed from the couch the monkey walked voluntarily, although somewhat stiffly, and within an hour was able to climb the side of a six foot high cage.

Data were also obtained from a monkey with catheters surgically implanted in the aorta and vena cava (#32, Touchstone). On the 45th day of the test, when the couch and monkey were being transferred to a scale for weighing, the venous catheter was inadvertently damaged and was non-functional for the remainder of the couch trial. The aortic catheter continued to function throughout the 90-day period in the couch, and the hematological data

shown in Table 3 were obtained on blood from this catheter. Daily nutrient intake and the amount of excreta were essentially the same in this monkey as those for the non-catheterized animal.

From the limited data, the major change in hematology appeared in the ratio of albumin to globulin. In both monkeys the albumin fraction of the blood plasma tended to drop rather precipitously after the midway point of the 90 day couch trials. Apparently this change can be attributed to the couch confinement, and is not aggravated by the presence of implanted vascular catheters.

Hemodynamics.

Hemodynamic data from the same monkey confined in the couch for 90 days (#32, Touchstone) are shown in Table 4. The last surgical implantation of catheters was made 16 days prior to confinement. Cardiac outputs could not be determined after the 45th day of the trial as the venous catheter was inadvertently removed. Arterial pressure measurements were continued throughout the 90 day period. The monkey in his couch was housed in a plywood box which readily allowed daily feeding, watering and waste removal without visual contact by the monkey; however, the laboratory noises were not shut out. A constant circulation of fresh air was introduced through a plenum chamber, and the temperature could be kept quite constant. A lamp located in the top of the isolation box furnished a constant green light of low intensity. The front panels of the isolation box were removed for 10 minute periods at two or three week intervals, at which times the animal was given gross physical examinations. No superficial signs of functional disability were noted during the course of the trial.

All measurements in Table 4 represented an average of several 10 second recording intervals. An attempt was made to take these measurements during the same time period each day, and the greater portion of all measurements

were taken during the afternoon. With the exception of couch day 54, aorta systolic and diastolic pressures tended to decrease in the course of the test.

Hemodynamic data from a mature pig-tailed monkey which was not continuously in the couch configuration are shown in Table 5. This monkey (#20, Benvolio) was placed in a couch one week following vascular catheterization. Following the formation of a fistula into the sub-hyoid pouch due to a faulty confinement jacket, the monkey was removed from his couch. Subsequent modifications of the restraint apparatus allowed him to be returned to the couch configuration. The sub-hyoid pouch fistula was still present at his demise. Death was apparently due to arteritis of the right coronary artery some four and one-half months following surgery. Venous and arterial catheters remained patent throughout this period. The measurements indicated in Table 5 for Day 147 (15 July 1964) were made twelve hours before the animal's death.

Continuous monitoring for a 24 hour period was carried out on #20, Benvolio, and the data obtained are shown in Table 6.

Hemodynamic information on two additional mature pig-tailed monkeys is shown in Table 7. One of these animals (#48, Clitus) died as a result of an accidental abrupt pulling out of the vascular catheters. Both catheters had been patent up to the time of the accident. The other monkey (#3, Tybalt) survived subsequent surgical removal of the vascular catheters.

A complete tabulation of the ranges of hemodynamic data determined during this report period from 5 mature pig-tailed monkeys is summarized in Table 8. Each individual observation on respiratory rate, heart rate and vascular pressure was calculated from at least a 10 second recording period. Varying conditions of environment were involved.

Periodic checks for vascular catheter patency were made on a surgically implanted immature rhesus monkey. This monkey was retaped and jacketed at

each patency check and returned to his cage. The venous and arterial catheters were functional at 200 days post surgery.

Nutrition Studies.

In order to increase the reliability and simplify the delivery of food and water to the experimental primate, an investigation has been made in regard to the use of fluid diets. Two commercially available formula diets, vanilla flavored Nutrament (also referred to as Diet #2) and Enfamil with Iron (also referred to as Diet #3), were fed to four growing male pig-tailed monkeys. These disease-free monkeys had previously been fed dry feed pellets (also referred to as Diet #1) for a period of one year. During this time water was available ad libitum to a limit of 900 ml per day. During the experimental period the total daily ration of fluid diet was placed in a bottle dispenser which the monkeys had previously used for water consumption. To facilitate the measurement of the liquid diets, the monkeys were presented with 800 kilocalories of the diet #2, or 780 kilocalories of diet #3. Under the dry feed pellet regime, 700 kilocalories per day were available to each monkey. The fluid contained in the diet was the only source of exogenous water for the monkeys during the 126 day experimental period. Body weights were determined twice weekly before the daily ration was fed. Weekly blood samples were withdrawn into a lightly heparinized syringe by venipuncture of the lesser saphenous vein. Twenty-four hour feces and urine samples were collected on four consecutive days each week.

Metabolic and hematological summaries of the pre-experimental control period and the odd numbered weeks during the experimental period are shown in Tables 9, 10, 11, 12.

The monkeys accepted both diets satisfactorily, although the Nutrament diet would appear to be the one of preference. Some diarrhea was noted on two of the monkeys during the first two weeks of the experimental period.

During the remainder of the trial rather moist but formed feces were in evidence. The amount of daily feces production was not reduced when compared to the control period. However, it must be noted that the dry feed control ration had a low fiber content. Frozen acidified samples of urine and feces for the last six weeks of the experimental, and six weeks of a post experimental control period, will be analyzed for nitrogen and certain mineral constituents. Preliminary nitrogen analysis and the growth record would strongly indicate that the monkeys were maintained in a positive nitrogen balance under the fluid diet regime.

The development of a feeding dispenser capable of reliable performance in periods of weightlessness is currently under investigation by this laboratory. A single preparation satisfying the nutrient and water requirements of the experimental primate should minimize associated instrumentation problems.

Urine Collection and Analysis.

Urinary catheters of varying internal diameters have been successfully implanted by suprapubic cystostomy into the urinary bladder of several pig-tailed monkeys, and have remained functional for as long as 20 days. However, the conditions necessary for 90 day catheterization have not yet been ascertained.

An analysis of urinary constituents is shown in Table 13. These data were obtained from frozen 3-hour interval samples collected and stored in an automatic collector. In addition to the quantitative tests, qualitative tests for sugar, ketones, blood and protein were performed. The urine samples were negative in respect to these constituents, with the exception of the detection of free hemoglobin in some of the samples collected on May 5th and 6th.

Body Composition Measurements.

The total body water content was determined on four pig-tailed monkeys with chronically implanted aortic and vena caval catheters. One hundred microcuries of sterile tritiated water were injected into the animals by means of a syringe fitted with a Chaney adapter. To determine the equilibration time of tritiated water in body water, 3 ml blood samples were taken from 2 pig-tailed monkeys at 15, 30, 60, 90, 120 and 240 minutes after the administration of the labeled water. Three milliliters of blood were also taken from each of these monkeys after 2, 4, 7, 9, 11, 14, 21, 24 and 28 days to determine the biological half-life of the tritiated water. Water was recovered from the blood samples by vacuum distillation and counted in a liquid scintillation spectrometer. The counts per milliliter of body water after equilibration were compared with that of a standard obtained by diluting an identical dose in a known volume of water and total body water content calculated by application of the dilution principle.

The percentage of body fat was calculated from the following formula:

$$\% \text{ fat} = 100 - \frac{\% \text{ water}}{0.732}$$

Knowing the total body weight of the animal at the time of the trial, the total body fat was computed. Fat free body weight was calculated by difference.

Table 14 shows the equilibration time and the biological half-life of tritiated water in body water of two pig-tailed monkeys and the body water and body fat content of four pig-tailed monkeys.

Table 1

Anthropoidimetric Measurements of a Growing Male Pig-tailed Monkey (#38, Francisco) - Birth date 17 December 1963)

Age in days (Birth date = Day 1)	90	168
Body Weight (kg)	0.91	1.25
1. Crown to base of tail (cm)	28.3	31.0
2. Crown to tip of tail (cm)	41.2	43.4
3. Midline around shoulder to tip of finger (cm)	30.9	32.5
4. Midline around hip to tip of toe (cm)	28.8	32.8
5. Greater trochanter to knee joint (cm)	8.1	8.6
6. Knee joint to lateral malleolus (cm)	8.4	10.1
7. Humeral head to surface radial epicondyle (cm)	7.5	8.2
8. Tip of olecranon to ulnar styloid (cm)	8.5	9.2
9. Circumference of head occipital to supraoptic above ears (cm)	22.0	23.5
10. Circumference of chest at nipples (cm)	17.8	19.7
11. Circumference of abdomen at umbilicus (cm)	15.1	15.5
12. Width of head above ears (cm)	6.2	6.3
13. Interpupillary distance (cm)	2.2	2.3
14. Length of right foot (cm)	9.6	10.6
15. Length of right hand (cm)	6.8	7.7

Table 2

Metabolic and Hematology Data from a Pig-tailed Monkey (#2, Bottom) without Implanted Catheters Confined in a Couch Configuration

	Control Period	No. of day in couch configuration			
		18th	39th	75th	82nd	89th
Body Weight (kg)	10.79	10.22	9.89	10.51	10.18	10.39
Feed/day (gm)	198	178	186	198	179	195
Water/day (ml)	600	537	650	617	590	637
Urine (ml/day)	468	488	411	328	233	310
Feces (gm/day)	45	41	41	47	39	38
RBC x 10^6/mm^3	6.35		6.40	5.60	6.90	6.24
WBC x 10^3/mm^3	8.2		7.5	8.8	10.1	11.3
Lymphocytes (%)	50.5		41.0	38.0	32.5	33.5
Monocytes (%)	5.8		2.0	4.0	3.0	4.0
Neutrophils (%)	41.0		48.0	56.0	61.5	60.0
Eosinophils (%)	1.7		0.0	1.0	2.0	1.5
Basophils (%)	1.0		0.5	0.5	1.0	1.5
Hemoglobin (g/100 ml whole blood)	13.8		11.2	11.1	9.1	11.1
Total Plasma Protein (g/100 ml plasma)	7.1		7.9	--	8.3	6.7
Plasma Albumin " " "	--		5.1	--	3.1	2.8
Plasma Globulin " " "	--		2.8	--	5.2	3.9
A/G Ratio	--		1.8	--	0.6	0.7

Table 3

Hematological Data from a Pig-tailed Monkey (#32, Touchstone) with Implanted Catheters Confined in a Couch Configuration

	Control Period	No. of day in couch configuration			
		28th	63rd	77th	84th
RBC x $10^6/mm^3$	5.62	4.95	4.83	5.25	4.85
WBC x $10^3/mm^3$	12.7	10.0	7.4	11.5	11.2
Lymphocytes (%)	39.5	46.0	45.5	48.5	39.5
Monocytes (%)	4.0	1.5	1.5	1.5	1.0
Neutrophils (%)	54.0	49.5	52.0	48.0	56.5
Eosinophils (%)	3.0	2.5	0.5	1.5	3.0
Basophils (%)	0.0	0.5	0.5	0.5	0.0
Hemoglobin (g/100 ml whole blood)	8.2	10.2	7.8	8.2	9.0
Total Plasma Protein (g/100 ml plasma)	8.6	10.3	7.2	6.4	6.5
Plasma Albumin " " "	4.5	4.8	2.6	2.8	2.9
Plasma Globulin " " "	4.1	5.5	3.6	3.6	3.6
A/G Ratio	1.1	0.9	0.7	0.8	0.8

Table 4

Hemodynamic Data from a Mature Pig-tailed Monkey Confined in a Couch Configuration (#32, Touchstone) (weight range from 7.82 to 8.02 kg)

Trial Day (in couch)	1	29	33	34	41	46	54	59	66	72	81	88
Respiratory Rate (breaths/min)	31	28	25	22	23	26	30	33	26	24	36	31
Heart Rate (beats/min)	181	184	161	148	179	168	171	171	175	163	156	177
Aorta Systolic Pressure (mm Hg)	145	131	120	125	122	127	155	127	129	110	103	112
Aorta Diastolic Pressure (mm Hg)	102	93	80	82	83	84	104	92	88	77	68	88
Aorta Pulse Pressure (mm Hg)	42	38	40	43	39	43	51	34	41	34	35	34
Aorta Mean Pressure (mm Hg)	120	112	100	102	100	104	138	106	108	93	85	101
Mean Venous Pressure (mm Hg)			-4	-4	-4							
Pulmonary Circulation Time (sec)			3.53	3.55	3.29							
Complete Circulation Time (sec)			6.42	6.38	6.58							
Beats/Complete Circulation			16.9	16.7	19.3							
Blood Volume (ml)			510	538	487							
Cardiac Output (liters/min)			1.20	1.05	1.21							
Cardiac Output (liters/kg/min)			0.153	0.134	0.156							
Cardiac Index (liters/m^2/min)			2.58	2.26	2.60							
Systemic Resistance (dyne sec/cm^2)			7340	8150	6600							
Cardiac Work (watts)			0.277	0.240	0.254							
Stroke Volume (ml/beat)			7.05	6.71	6.97							
Stroke Index (ml/beat/kg body wt)			0.90	0.85	0.89							

Table 5

Hemodynamic Data from a Mature Pig-tailed Monkey (#20, Benvolio)

Date	25 Mar 64	14 Apr 64	15 Apr 64	15 Jul 64
Day Following Catheter Implantation	42	62	63	147
Respiratory Rate (breaths/min)	34	29	28	38
Heart Rate (beats/min)	189	153	143	172
Aorta Systolic Pressure (mm Hg)	144	120	122	192
Aorta Diastolic Pressure (mm Hg)	101	88	88	140
Aorta Pulse Pressure (mm Hg)	43	32	34	52
Aorta Mean Pressure (mm Hg)	121	98	97	167
Venous Pressure (mm Hg)				+ 2.62
Pulmonary Circulation Time (sec)		4.76	4.40	4.39
Complete Circulation Time (sec)		8.23	8.30	9.74
Beats/Complete Circulation		21.0	19.8	27.2
Blood Volume (ml)			715	606
Cardiac Output (liters/min)		1.31	1.36	1.00
Cardiac Output (liters/kg/min)		0.163	0.169	0.124
Cardiac Index (liters/m^2/min)		2.78	2.88	2.11
Systemic Resistance (dyne sec/cm^2)		6010	5770	11,920
Cardiac Work (watts)		0.285	0.292	0.407
Stroke Volume (ml/beat)		8.63	9.48	6.37
Stroke Index (ml/beat/kg body wt)		1.07	1.18	0.79

Table 6

Consecutive Hourly Physiologic Measurements from a Mature Pig-tailed Monkey (#20, Benvolio)

Hour	Respiration Rate breaths/min	Heart Rate beats/min	Aorta Pressures in mm Hg				Rectal Temperature °C
			Systolic	Diastolic	Pulse	Mean	
1900	28	168	152	111	41	119	--
2000	27	168	150	111	39	119	--
2100	--	156	139	102	37	115	--
2200	27	152	162	120	42	126	--
2300	--	144	154	111	43	126	--
2400	--	146	152	108	44	126	37.8
0100	32	144	155	111	44	127	37.8
0200	26	144	148	106	42	125	37.8
0300	26	145	143	103	40	124	37.8
0400	28	162	156	110	46	124	37.7
0500	28	150	157	113	44	126	37.7
0600	28	158	152	109	43	126	37.6
0700	25	144	148	108	40	125	37.5
0800	26	138	146	106	40	125	37.3
0900	--	144	148	105	43	126	37.3
1000	--	138	140	107	33	126	--
1100	32	132	162	116	46	127	37.3
1200	26	138	164	114	50	127	--
1300	--	--	--	--	--	127	--
1400	--	138	165	125	41	127	37.6
1500	--	138	166	121	41	127	--
1600	--	144	164	119	45	126	--
1700	--	--	--	--	--	--	--
1800	--	150	164	116	48	127	37.7

Table 7

Hemodynamic Data from Two Mature Pig-tailed Monkeys Following Chronic Catheter Implantation

Animal Weight	#3,Tybalt 10.65 kg	#48, Clitus 8.13 kg		
Date	11 Mar 64	21 May 64	25 May 64	26 May 64
Day following catheter implantation	13	23	27	28
Respiratory Rate (breaths/min)	29	24	33	37
Heart Rate (beats/min)	173	195	207	208
Aorta Systolic Pressure (mm Hg)	134	109	132	133
Aorta Diastolic Pressure (mm Hg)	102	65	72	79
Aorta Pulse Pressure (mm Hg)	32	44	60	53
Aorta Mean Pressure (mm Hg)	113	83	102	108
Mean Venous Pressure (mm Hg)	--	-4	-1	-7
Pulmonary Circulation Time (sec)	4.43			3.35
Complete Circulation Time (sec)	7.57			5.97
Beats/Complete Circulation	20.1			20.6
Blood Volume (ml)				659
Cardiac Output (liters/min)	1.49			1.57
Cardiac Output (liters/kg/min)	0.140			0.193
Cardiac Index (liters/m^2/min)	2.61			3.32
Systemic Resistance (dyne sec/cm^2)	5,630			5,920
Cardiac Work (watts)	0.418			0.376
Stroke Volume (ml/beat)	8.66			7.62
Stroke Index (ml/beat/kg body wt)	0.81			0.94

Table 8

Range in Hemodynamic Data from 5 Unanesthetized, Male Pig-Tailed Monkeys Weighing between 7.5 and 11.0 kg

	No. of Observations	Maximum	Minimum
Respiratory Rate (breaths/min)	97	42	20
Heart Rate (beats/min)	97	222	132
Aorta Systolic Pressure (mm Hg)	97	215	106
Aorta Diastolic Pressure (mm Hg)	97	155	65
Aorta Pulse Pressure (mm Hg)	97	61	29
Aorta Mean Pressure (mm Hg)	97	182	83
Mean Venous Pressure (mm Hg)	47	+10	-10
Pulmonary Circulation Time (sec)	57	5.04	3.15
Complete Circulation Time (sec)	57	8.86	5.55
Beats/Complete Circulation	54	24.6	14.3
Blood Volume (ml)	28	827	457
Cardiac Output (liters/min)	49	1.80	0.83
Cardiac Output (liters/kg/min)	49	0.223	0.101
Cardiac Index (liters/m^2/min)	49	3.78	1.75
Systemic Resistance (dyne sec/cm^2)	45	12,870	4,710
Cardiac Work (watts)	45	0.447	0.215
Stroke Volume (ml/beat)	49	10.8	5.9
Stroke Index (ml/beat/kg body wt)	49	1.34	0.67

Table 9

Pig-tailed Monkey (#17, Bagot) on Enfamil(R) with Iron (Diet #3)
1.35 kcal/ml

		Dry Diet Control Period	Fluid Diet Experimental Period								
Week:			1st	3rd	5th	7th	9th	11th	13th	15th	17th
Ending:			3-15	3-29	4-12	4-26	5-10	5-24	6-7	6-21	7-5
					**				**		
Caloric Intake	(kcal/day)	615	560	614	569	509	651	552	485	621	745
Fluid Intake	(ml/day)	675	421	462	428	383	482	409	359	460	552
Body Weight	(kg)	7.04	6.68	6.82	6.79	6.76	6.91	7.21	7.19	7.21	7.47
Urine/24 hrs	(ml)	341	111	155	163	102	185	169	203	169	203
Feces/24 hrs	(gms)	32	* 31	22	25	19	31	32	30	17	38
Hematocrit	%	42.5	41.0	43.0	52.0	45.0	40.0	43.0	44.0	42.0	45.0
RBC x $10^6/mm^3$		6.07	5.90	5.30	7.35	6.79	5.75	5.05	7.05	6.23	6.95
WBC x $10^3/mm^3$		10.8	9.4	11.6	13.0	16.8	14.0	10.0	10.0	11.6	13.4
Monocytes	%	1.0	2.0	1.0	3.0	0.5	--	3.0	2.0	2.0	2.0
Lymphocytes	%	73.0	57.0	48.5	38.0	34.0	--	47.5	50.0	49.5	50.0
Neutrophils	%	24.0	39.5	48.5	58.5	64.5	--	48.0	46.5	47.5	46.5
Eosinophils	%	2.0	1.0	1.0	0.5	0.5	--	1.5	1.0	1.0	0.0
Basophils	%	0.0	0.5	1.0	0.0	0.0	--	0.0	0.5	0.0	1.5
Hemoglobin	gm%	12.3	12.0	11.4	10.6	12.6	12.9	11.5	11.3	12.4	13.2
Plasma Protein	gm%	--	7.1	7.1	6.4	8.9	6.5	6.5	6.9	6.7	6.9
Plasma Albumin	gm%	--	3.7	4.0	3.9	5.6	3.3	3.9	3.7	4.1	3.6
Plasma Globulin	gm%	--	3.4	3.1	2.5	3.3	3.2	2.6	3.2	2.6	3.3
Albumin Globulin	Ratio	--	1.08	1.29	1.56	1.70	1.03	1.50	1.16	1.58	1.09
Blood Glucose	mg%	--	--	--	--	102	--	64	74	59	56
MCHb γγ		20	20	21	14	18	22	23	16	20	19

* Diarrhea

** TB neg.

Table 10

Pig-tailed Monkey (#18, Escalus) on Enfamil with Iron(R) (Diet #3)
1.35 kcal/ml

		Dry Diet	Fluid Diet Experimental Period								
		Control Period	Week: 1st	3rd	5th	7th	9th	11th	13th	15th	17th
			Ending: 3-15	3-29	4-12	4-26	5-10	5-24	6-7	6-21	7-5
					**				**		
Caloric Intake	(kcal/day)	600	750	780	661	772	725	780	780	780	780
Fluid Intake	(ml/day)	900	564	577	497	572	537	577	577	577	577
Body Weight	(kg)	6.05	5.94	6.22	6.59	6.50	6.62	6.94	7.19	7.30	7.45
Urine/24 hrs	(ml)	482	162	233	156	170	176	195	266	269	298
Feces/24 hrs	(gms)	33	* 26	41	26	29	35	42	41	42	44
Hematocrit	%	43.0	40.0	45.0	52.0	43.0	42.0	40.0	40.0	43.0	42.0
RBC x 10^6/mm^3		6.68	6.30	6.80	5.85	6.01	5.80	6.35	5.65	6.72	5.70
WBC x 10^3/mm^3		10.2	12.4	9.9	10.6	8.6	13.7	11.3	13.6	13.4	6.5
Monocytes	%	0.0	1.0	3.5	1.0	1.5	1.0	2.5	2.5	2.0	2.5
Lymphocytes	%	67.5	64.0	50.0	48.5	33.5	56.0	51.0	50.0	49.0	51.0
Neutrophils	%	32.5	34.0	45.5	49.5	65.0	40.5	48.0	47.5	46.5	44.0
Eosinophils	%	0.0	0.5	1.0	0.5	0.0	0.5	0.5	0.0	2.0	1.0
Basophils	%	0.0	0.5	0.0	0.5	0.0	0.0	0.5	0.0	0.5	1.5
Hemoglobin	gm%	12.4	11.3	10.9	9.1	12.4	12.3	11.7	13.9	12.3	12.1
Plasma Protein	gm%	--	7.0	7.4	7.7	7.3	6.3	7.3	6.8	7.1	7.2
Plasma Albumin	gm%	--	3.5	3.9	5.2	4.0	3.4	3.4	2.9	3.8	3.7
Plasma Globulin	gm%	--	3.5	3.5	2.5	3.3	2.9	3.9	3.9	3.3	3.5
Albumin Globulin	Ratio	--	1.00	1.11	2.08	1.21	1.17	.87	.74	1.12	1.06
Blood Glucose	mg%	--	--	--	--	68	76	56	69	90	48
MCHb γγ		19	18	16	15	21	21	18	25	18	21

* Diarrhea

** TB neg.

Table 11

Pig-tailed Monkey (#19, Mercutio) on Nutrament(R) (Diet #2)
1.08 kcal/ml

		Dry Diet	Fluid Diet Experimental Period								
		Control Period	Week: 1st	3rd	5th	7th	9th	11th	13th	15th	17th
			Ending: 3-15	3-29	4-12	4-26	5-10	5-24	6-7	6-21	7-5
					**	***			**		
Caloric Intake	(kcal/day)	600	756	800	777	445	660	791	608	634	708
Fluid Intake	(ml/day)	633	700	740	710	412	611	732	563	619	656
Body Weight	(kg)	5.71	5.59	5.88	5.85	5.88	6.17	6.33	6.50	6.39	6.53
Urine/24 hrs	(ml)	328	245	315	250	165	258	336	240	209	205
Feces/24 hrs	(gms)	33	* 46	38	42	18	45	40	39	37	38
Hematocrit	%	41.0	45.0	--	52.0	48.0	46.0	41.0	48.0	49.0	47.0
RBC x $10^6/mm^3$		5.10	5.30	6.30	7.00	7.10	6.35	6.75	7.80	7.35	7.00
WBC x $10^3/mm^3$		9.6	9.4	8.1	13.3	19.4	13.6	13.3	9.0	12.1	14.7
Monocytes	%	5.0	4.0	3.5	1.0	5.0	4.0	1.5	1.5	0.5	2.0
Lymphocytes	%	46.5	34.5	50.0	47.0	46.0	69.0	60.0	49.0	50.0	48.5
Neutrophils	%	44.5	56.5	46.0	50.5	49.0	26.0	38.0	49.5	48.5	47.0
Eosinophils	%	3.5	3.5	0.5	1.5	0.0	0.5	0.5	0.0	0.0	2.0
Basophils	%	3.5	3.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.5
Hemoglobin	gm%	12.1	12.0	10.9	11.4	14.3	12.8	13.7	13.2	13.1	13.3
Plasma Protein	gm%	--	7.4	--	6.6	8.7	7.6	7.2	8.1	5.8	6.9
Plasma Albumin	gm%	--	3.9	--	3.2	5.1	3.9	4.1	3.5	2.9	4.1
Plasma Globulin	gm%	--	3.5	--	3.4	3.6	3.7	3.1	4.6	2.9	2.8
Albumin Globulin	Ratio	--	1.11	--	.94	1.42	1.05	1.32	.76	1.00	1.46
Blood Glucose	mg%	--	--	--	--	141	109	144	50	150	--
MCHb γγ		24	23	17	16	20	20	20	17	18	19

* Diarrhea - traces of blood.
** TB neg.
*** Refused chocolate flavored Nutrament, given on a Sunday by mistake. Spout plugged one day.

Table 12

Pig-tailed Monkey (#21, Lysander) on Nutrament(R) (Diet #2)
1.08 kcal/ml

		Dry Diet	Fluid Diet Experimental Period								
		Control Period	Week: Ending: 1st 3-15	3rd 3-29	5th 4-12	7th 4-26	9th 5-10	11th 5-24	13th 6-7	15th 6-21	17th 7-5
					* **				**		
Caloric Intake	(kcal/day)	700	800	800	800	800	800	800	800	800	800
Fluid Intake	(ml/day)	900	740	740	740	740	740	740	740	740	740
Body Weight	(kg)	6.68	6.79	7.19	7.45	7.53	7.59	7.67	7.93	8.04	7.90
Urine/24 hrs	(ml)	455	284	310	263	333	306	330	338	331	326
Feces/24 hrs	(gms)	30	38	32	35	31	34	49	66	33	48
Hematocrit	%	44.0	41.0	42.0	50.0	44.0	43.0	43.0	43.0	44.0	46.0
RBC x $10^6/mm^3$		6.50	6.00	6.20	7.25	6.00	5.10	6.00	6.25	7.08	6.65
WBC x $10^3/mm^3$		5.0	8.0	5.9	6.4	9.1	13.0	9.2	9.2	9.3	9.2
Monocytes	%	2.5	2.0	3.0	1.5	3.0	1.0	1.0	1.5	1.5	3.0
Lymphocytes	%	36.0	37.0	42.0	52.0	45.0	52.0	51.0	40.5	49.0	47.0
Neutrophils	%	55.5	55.0	50.5	45.0	50.0	47.0	48.0	57.0	48.5	47.5
Eosinophils	%	1.0	1.0	3.5	1.5	1.5	0.0	1.0	1.0	1.0	1.0
Basophils	%	0.5	5.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	1.5
Hemoglobin	gm%	10.4	10.2	11.3	11.5	12.7	12.0	12.0	12.3	13.0	13.8
Plasma Protein	gm%	--	6.9	7.2	7.9	8.0	6.8	5.2	7.5	5.7	6.3
Plasma Albumin	gm%	--	3.8	4.1	5.0	4.8	3.5	2.2	3.9	3.2	3.0
Plasma Globulin	gm%	--	3.1	3.1	2.9	3.2	3.3	3.0	3.6	2.5	3.3
Albumin Globulin	Ratio	--	1.23	1.32	1.72	1.50	1.06	.73	1.08	1.28	.91
Blood Glucose	mg%	--	--	--	--	44	67	38	48	--	42
MCHb γγ		16	17	18	16	21	20	20	20	18	21

* Small ulcer, left corner of mouth.

** TB neg.

Table 13

Analysis of Urinary Constituents of a Pig-tailed Monkey (#32, Touchstone) Collected and Frozen in an Automatic Urine Collection Device

		Average of triplicate analysis for 24 hour sample		
		From 5 May 64 2000 To 6 May 64 2000	From 20 May 64 1000 To 21 May 64 1000	
Volume of Urine	ml/hr	9.12	15.3	
Ammonia	mmoles/hr	0.0014	0.0051	
Phosphate	"	0.000777	0.000222	
Chloride	"	0.697	0.729	
Sulfate	"	0.116	0.133	
Sodium	"	0.530	0.685	
Potassium	"	0.530	0.398	
Na/K	"	1.00	1.72	
Calcium	"	0.261	0.115	Atom. Absorp. Spectroph.
Magnesium	"	0.0724	0.0613	"
Urea	"	3.20	3.82	
Uric Acid	"	0.00405	0.00372	
Creatinine	"	0.0613	0.0639	
Glucose	"	0.0374	0.0576	
5 OHIAA	µmoles/hr	0.155	0.186	
17-Ketosteroid	"	0.797	0.691	
17-OH steroid	"	0.237	0.187	
Epinephrine	nmoles/hr	1.597	0.297	
Norepinephrine	"	1.260	0.619	
Total osmotic pressure		5.82	5.86	

Table 14

Body Composition Measurements of 4 Pig-tailed Monkeys

No.	Name	Total Body Weight (kg)	Total Body Water (liters)	(%)	Total Body Fat (kg)	(%)	Fat-Free Body Weight (kg)	(%)	Eq.* Time (min)	$t_{\frac{1}{2}}$ ** (days)
20	Benvolio	8.69	5.84	67.2	0.71	8.2	7.98	91.8	120	7
32	Touchstone	7.76	5.21	67.1	0.64	8.3	7.12	91.7	120	6
49	Claudius	9.25	5.31	57.4	2.00	21.6	7.25	78.4		
56	Titinius	7.33	5.18	70.7	0.25	3.4	7.08	96.6		

* Equilibration time of tritiated water in body water.

** Biological half-life of tritiated water.